

11. COMETS EXPERIMENT

The National Space Development Agency (NASDA) of Japan and NASA (TRMM Project office) have established an agreement to conduct experimental operations with TRMM in conjunction with the Japanese Communications and Broadcasting Engineering Test Satellite (COMETS). The purpose for "experimental" telemetry and command relay operations is to verify the full capability of the COMETS as a data relay satellite, with performance comparable to the NASA TDRSS. An additional objective is a NASA/NASDA operational demonstration of Space Network Interoperability Panel (SNIP).

The COMETS experiment will begin in 6 months after TRMM launch and last approximately one year (with a potential gap after 4-months for NASDA to evaluate data). The experiment will consist of 60 science events, 24 tracking events, and the electronic exchange of state vector data in the Improved InterRange Vector (IIRV) format. COMETS events will not be treated as an operational interface, but instead will be treated as an experiment and as such will only be conducted on a non-interference basis with ongoing TRMM operations.

The 60 science events will be performed in weekly periods, with up to five events per week (not to exceed one per day). The 24 tracking events will consist of four tracking experiments. Each experiment will require six successful COMETS events during a 30-hour period. The tracking experiment will be performed four times during the COMETS experiment. The NASA and COMETS FDFs will exchange and compare ephemerides computed for TRMM and COMETS tracking data, respectively. NASA and NASDA will also exchange tracking data taken during the tracking experiments.

The TRMM/COMETS experiment will be performed by use of the existing GSFC institutional support facilities operated by the MO&DSD, Code 500, and Nascom provided communication services. These ground facilities will provide support for command and telemetry, communications, command management, and data capture and processing. The capabilities provided during COMETS events should be identical to those provided during TDRS events. TRMM telemetry on VC0 will be routed to the MOC for routine health and status monitoring. The FDF will provide mission analysis support during the experiment. Recorded playback data will be captured at the COMETS Ground Terminal (CGT) and forwarded to the NASDA Earth Observation Center (EOC). Playback VCDUs downlinked at 2.048 Mbps will not be forwarded to GSFC during COMETS events. Figure 11-1 provides an end-to-end data flow diagram for the TRMM/COMETS experiment.

NASDA will provide a Real-time Operations and Planning Terminal (ROPT), located in the MOC. The ROPT will be utilized in support of the COMETS experiment. The ROPT is a laptop, UNIX based system, equipped with a serial printer and 4-mm tape unit. The ROPT provides an interface to the COMETS NCC for resource scheduling; provides a capability to transmit operations control messages (similar to GCMRs conducted with NASA's Space Network) to the COMETS NCC; receipt of SN messages (similar to User Performance Data

{UPD})) reflecting COMETS link status and configuration.; and a free flowing text message capability to exchange messages between NASA and NASDA.

Throughout the COMETS experiment, the NASA FDF will provide orbital support in conjunction with the COMETS FDF. Support will include the computation and transmission of TRMM and TDRS state vectors to the COMETS FDF on a scheduled basis, and provisions of

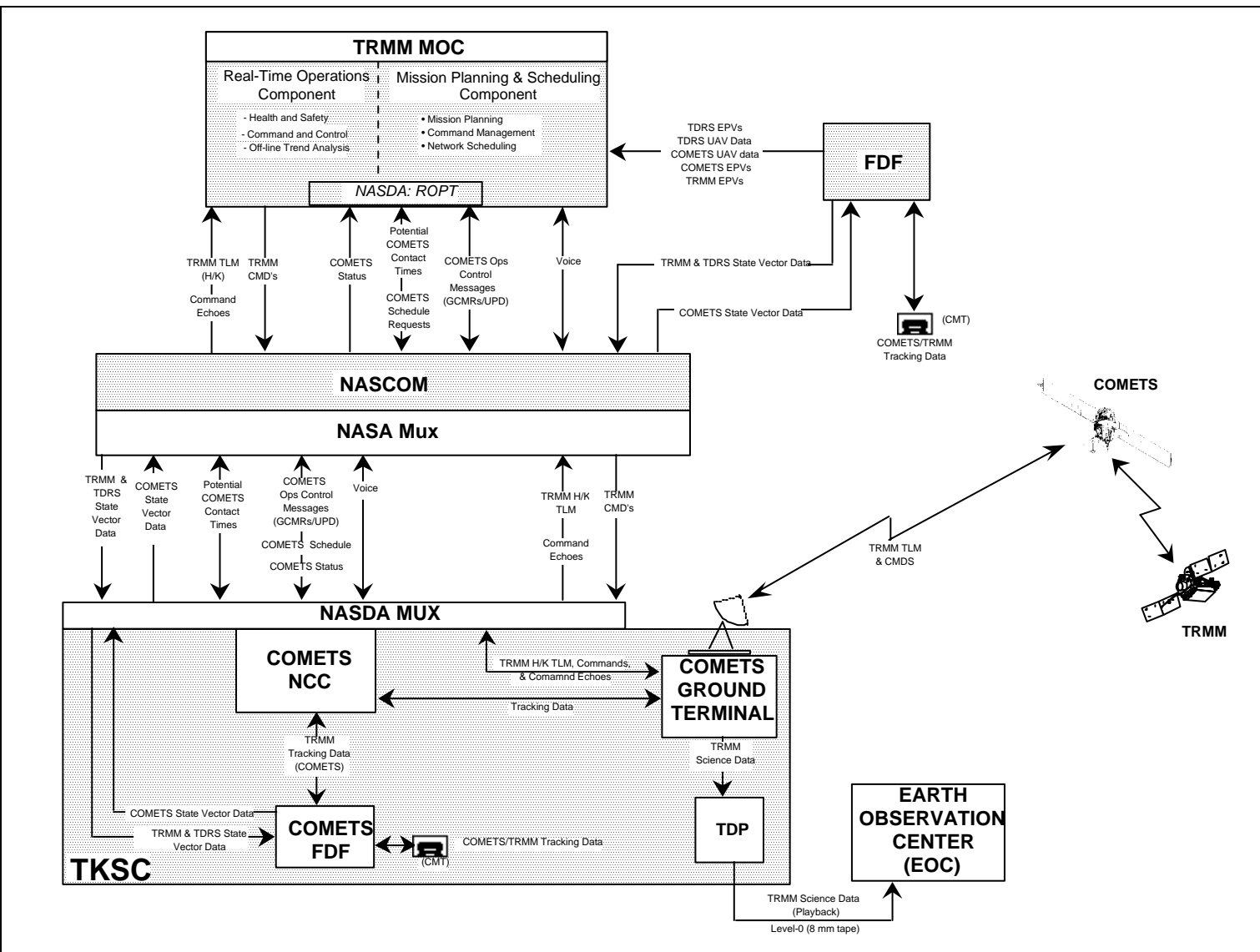


Figure 11-1 TRMM/COMETS End-to-End Data Flow Diagram

COMETS User Antenna Views (UAVs) to the MOC on a regular basis. The FDF will also provide COMETS EPVs to the MOC by translating COMETS IIRV information.

All command and control of the TRMM spacecraft during COMETS events will be performed by the TRMM FOT from the TRMM MOC located at GSFC. Commands issued to TRMM during COMETS events will be relayed to TRMM via the CGT in a through-put mode.

11.1 MISSION PLANNING AND SCHEDULING

COMETS Mission planning and scheduling functions will be supported by the ROPT, provided by NASDA and located in the MOC. Interaction between NASA and NASDA will be required for the scheduling and planning of COMETS events. All TDRS and COMETS events must be separated by at least 20 minutes, to avoid short-turnarounds at the MOC. For planning purposes, the TRMM/COMETS experiment is scheduled to begin in May 1998. Three months prior to the start of the experiment, the FOT will send the confirmed TDRS schedule to NASDA (via Fax) every week. During the three months prior to the experiment, NASDA will evaluate TRMM/TDRS schedules in attempt to look for patterns in the TDRS schedules.

Due to the nature of COMETS scheduling, NASDA must schedule potential TRMM/COMETS events one month in advance (potential events for May 1998 will be scheduled in April 1998). NASDA will provide the potential TRMM/COMETS experiment times to the TRMM MOC, one month in advance (via the ROPT). In an attempt to improve the success of scheduling TRMM/COMETS events, NASDA will select events that occur in the TDRS Zone of Exclusion (ZOE), when possible. After receipt of the confirmed TDRS schedule (Event Week Minus-2 {EW-2}), the FOT will select experiment events for the EW (from the potential events provided by NASDA), and provide to the COMETS NCC (via the ROPT). One day prior to the first scheduled event of an EW, the FOT and COMETS NCC will communicate to confirm support for scheduled experiment events.

This cycle will be repeated every month, for one year (or until the 84 event limit has been met). NASDA would like to have the following criteria met during the scheduling of COMETS events:

- a. No more than 1 event per day (except during tracking Experiment -- 6 events/30-hours)
- b. TBD to 10 events per month
- c. Experiment should span 12 - 16 months

Figure-11.1-1 provides a graphical illustration of the TRMM/COMETS scheduling timeline.

Throughout the planning process, the TRMM FOT will consider TDRS events times and maneuver times. Delta-V maneuvers will be performed during U.S. daytime, while COMETS events will take place during Japan daytime hours (U.S. nighttime), when possible. The

COMETS NCC will consider other COMETS activities while scheduling TRMM COMETS events. Beta angle constraints may be a factor, although further studies will be performed on-orbit.

The TRMM MOC off-line system will enable the FOT to manage the on-board Stored Command Processor (SCP) and build command loads with the inclusion of command sequences for

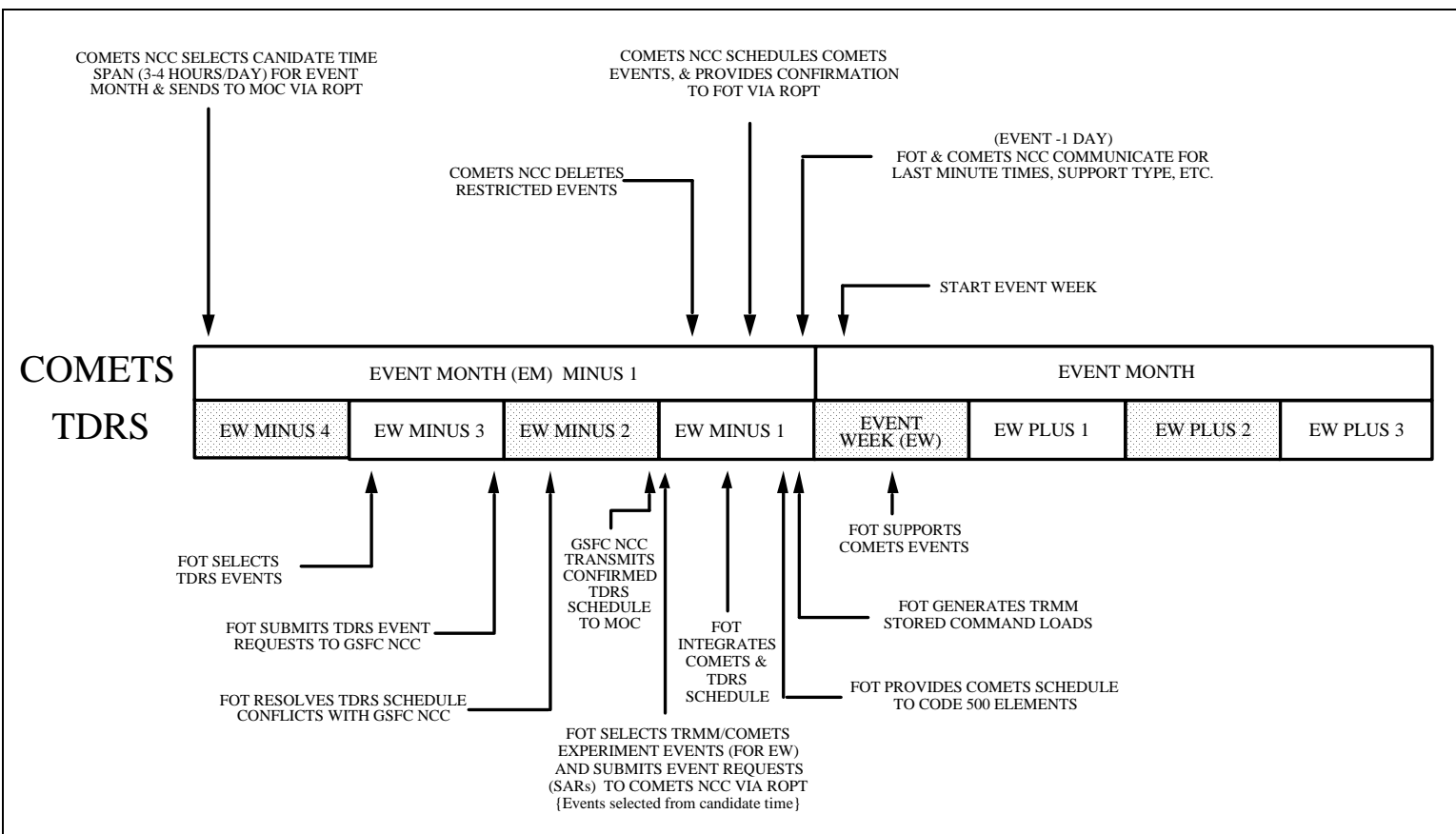


Figure 11.1-1 TRMM/COMETS Scheduling Timeline

COMETS AOS and LOS activities. The MOC will receive the COMETS EPV from FDF, generate a COMETS EPV command load, and uplink to the ACS SCP for execution.

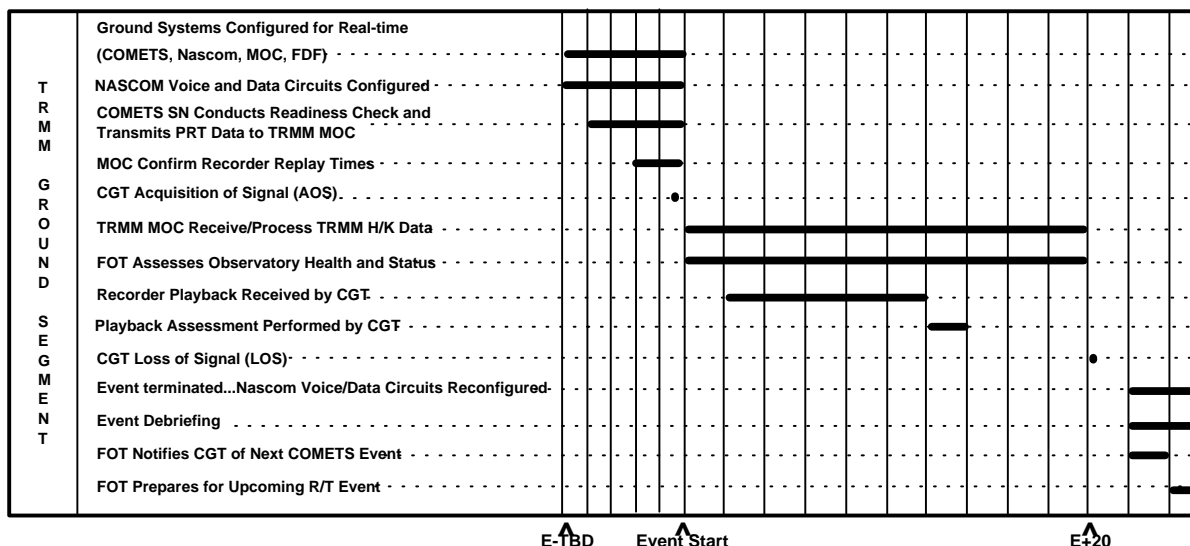
11.2 REAL-TIME OPERATIONS

COMETS real-time operations will be performed in a similar manner to real-time TDRS operations, as described in section 6 of this document. TRMM telemetry during COMETS events will be downlinked in a Data Group-1 (DG-1) Mode-3 configuration. The DG-1 Mode-3 configuration is comprised of two physical channels designated as the I and Q channels. The I-Channel will contain the low-rate housekeeping (H/K) data at 32 Kbps and the Q-Channel will contain the high-rate recorder playback data at 2.048 Mbps. The housekeeping data will be throughput to the MOC for spacecraft health and status monitoring, while the recorder playback data will only go to the NASDA EOC.

During real-time events with COMETS, the ROPT will be used to support R/T COMETS link control capabilities. The FOT will receive SN messages reflecting COMETS link status and configuration, and will be capable of sending operations control messages to the COMETS NCC.

The MOC backup string will be used during COMETS contacts and housekeeping telemetry will be displayed on the workstations of that string. During the pre-pass setup and configuration, PRT data will be transmitted to the MOC to verify proper line configuration and connectivity. The FOT will also transmit a few test commands to confirm the forward link configuration prior to the COMETS events. Nominal real-time health and status operations will be verified as with a TDRS event. The ability to send commands to the spacecraft will also be available via the CGT.

Figures-11.2-1 and 11.2-2 illustrate the typical activity scenarios for a TRMM/COMETS real-time experiment event (recorder playback and tracking event), respectively.



**Figure 11.2-1 TRMM/COMETS Real-Time Event Scenario
(Recorder Playback Event)**

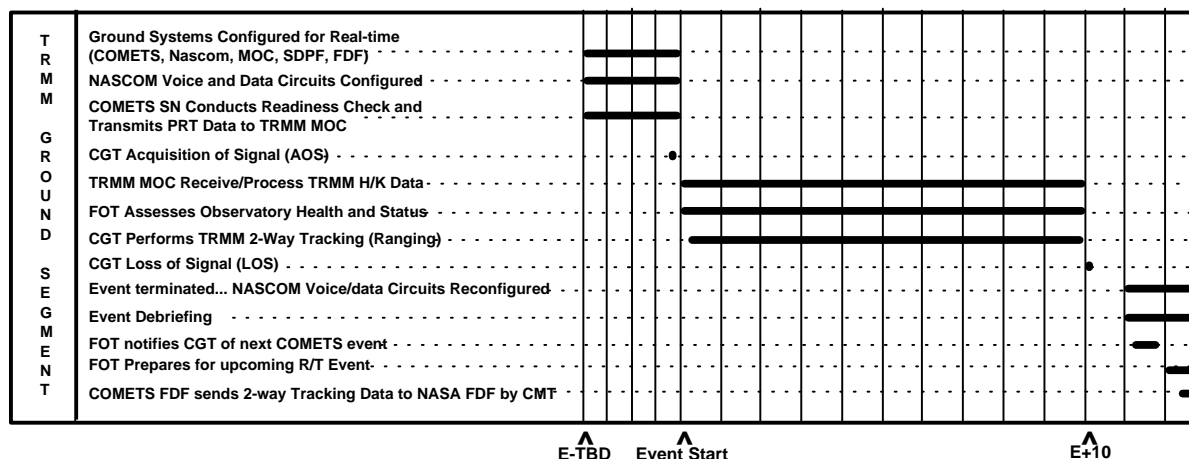


Figure 11.2-2 TRMM/COMETS Real-Time Event Scenario
(Ranging Event)

11.2.1 Solid State Recorder Operations

During the TDRS event (event prior to COMETS experiment support), the FOT will playback the closed data set. After successfully capturing the playback data, the FOT will nominally issue a real-time command to release the onboard stored data. However, during this particular event the FOT will instead issue a real-time Enable RTS command (where the RTS will contain a Release data set command). During the COMETS event, the same recorder data set will be downlinked. During the COMETS LOS sequence (stored commands), the FOT will include a Start RTS command (above mentioned RTS) to release the data set. If for some reason the COMETS event is missed, the onboard data set will still be released by stored commands. Figure 11.2-3 provides a graphical illustration of the TRMM/COMETS recorder operations approach.

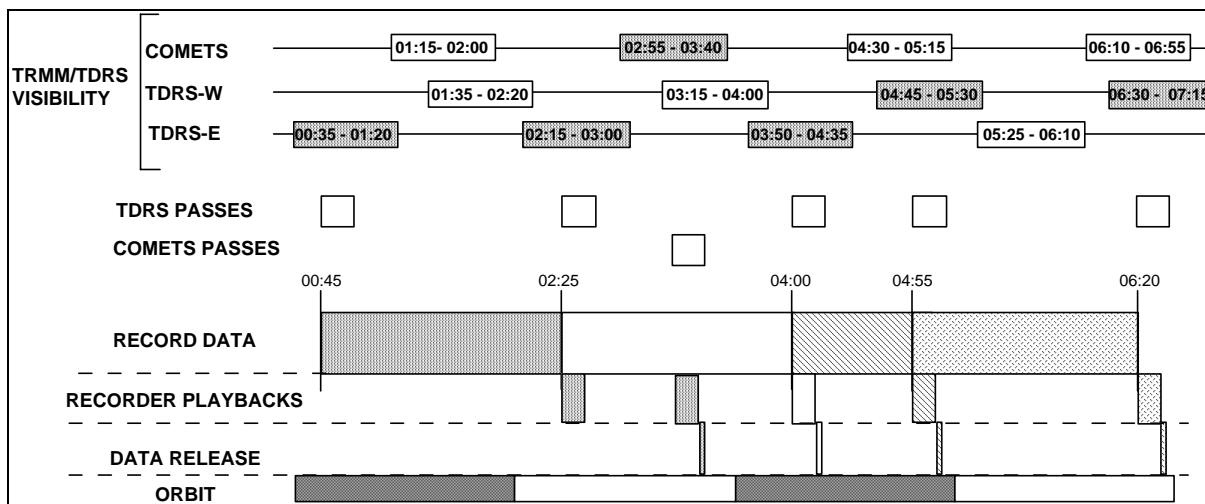


Figure 11.2-3 TRMM/COMETS Recorder Operations Approach

- After Data Set is successfully captured (via TDRS), the FOT will enable an on-board RTS> The RTS will contain a single 'Release Data Set' command. A stored ATS command scheduled to execute with the LOS sequence of the COMETS event will start the RTS.
- This approach will allow NASDA to receive the identical data set via COMETS as received via TDRS, without jeopardizing TRMM or TRMM data.